General

Guideline Title

Guidelines for the appropriate use of bedside general and cardiac ultrasonography in the evaluation of critically ill patients-part I: general ultrasonography.

Bibliographic Source(s)

Frankel HL, Kirkpatrick AW, Elbarbary M, Blaivas M, Desai H, Evans D, Summerfield DT, Slonim A, Breitkreutz R, Price S, Marik PE, Talmor D, Levitov A. Guidelines for the appropriate use of bedside general and cardiac ultrasonography in the evaluation of critically ill patients-part I: general ultrasonography. Crit Care Med. 2015 Nov;43(11):2479-502. [106 references] PubMed

Guideline Status

This is the current release of the guideline.

This guideline meets NGC's 2013 (revised) inclusion criteria.

Recommendations

Major Recommendations

The levels of quality of evidence (A, B, C) and strength of recommendations (Strong [1], Weak [2]) are defined at the end of the "Major Recommendations" field.

Noncardiac Thoracic Imaging

Pleural Effusion

Suitability of Ultrasound to Establish the Diagnosis and Assist in Drainage

- The Panel recommends that ultrasound should be used to complement physical examination and conventional chest radiography to diagnose and localize a pleural effusion. Grade 1A.
- The Panel recommends that ultrasound guidance should be used to assist in drainage (including needle guidance), particularly of small or loculated effusions compared with landmark technique. Grade 1B.
- The Panel has no recommendation regarding the preference for use of either static or dynamic technique to do so.

Diagnosis of Pneumothorax

The Panel recommends that ultrasound should be used to complement or replace conventional chest radiography to diagnose a pneumothorax, depending on the clinical setting and need for rapid results. Grade 1A.

Diagnosis of Interstitial and Parenchymal Lung Pathology

The Panel suggests that a systematic approach incorporating bedside ultrasound may be a primary diagnostic modality for the intensive care unit (ICU) patient with respiratory failure. Grade 2B.

Abdominal Imaging

Ascites (Nontrauma Setting)

Suitability of Ultrasound to Establish the Diagnosis to Assist in Drainage

The Panel recommends that ultrasound guidance (instead of the landmark technique), whether real-time or preprocedure, should be used to determine the optimal location for performance of paracentesis. Grade 1B.

Acalculous Cholecystitis

Suitability of Ultrasound to Establish the Diagnosis

The Panel suggests that bedside ultrasonography may be used to provide additional valuable information to the clinical presentation to establish the diagnosis of acalculous cholecystitis. Grade 2C.

Ability of the Intensivist to Use Ultrasound to Establish the Diagnosis Accurately

The Panel suggests that intensivists/critical care providers should not personally perform ultrasound primarily for the diagnosis of acute cholecystitis. Grade 2B.

Mechanical Causes of Anuria/Oliguria

Suitability of Ultrasound to Establish the Diagnosis Thereof

The Panel suggests that ultrasonography may be used to exclude mechanical causes of acute renal failure in the ICU. Grade 2C.

Ability of the Critical Care Provider to Use Ultrasound to Establish the Diagnosis Accurately

The Panel has no recommendations regarding this issue due to the paucity of data.

Vascular Imaging

Deep Venous Thrombosis (DVT)

Complete versus Focused Examination of the Lower Extremities

The Panel recommends that a focused ultrasound technique using gray scale imaging to evaluate vein compression at the common femoral and popliteal veins should be used to diagnose most proximal DVTs (compared with contrast venography). Grade 1B.

Accuracy of Focused DVT Screening by Critical Care Providers

The Panel recommends that intensivists can reliably perform a focused screening examination by ultrasound to diagnose lower extremity proximal DVT. Grade 1B.

Imaging to Assist Intravascular Catheter Insertion

General Consideration

The Panel recommends that ultrasound guidance of vessel cannulation (compared with landmark technique) should be used to improve the success rate, shorten procedure time and reduce the risk of procedure-related complications such as pneumothorax. Grade 1B.

Components of the Examination

Static versus Dynamic (Preprocedure vs Real-time)

The Panel recommends that in most patients, the use of realtime ultrasound is preferred over static, preprocedure marking. Grade 1B.

Long Versus Short Axis

Although there are benefits to visualizing the vasculature in both short- and long-axis images by ultrasound, the Panel recommends that the short-axis view be used during insertion to improve success rate. Grade 1B.

One- Versus Two-person Ultrasound-guided Vascular Cannulation

The Panel recommends that one- (rather than two-) person technique is sufficient for ultrasound-guided vascular cannulation. Grade 1C.

The Use of Doppler

The Panel suggests that conventional B-mode imaging to assist in vessel cannulation should be used compared with using audible Doppler only with no imaging. Grade 2B.

The Use of Needle Guides

The Panel has no recommendation regarding routine use of a device placed on the ultrasound transducer to guide needle placement. This should be left to provider discretion.

Completion Examination

The Panel suggests that a detailed postcannulation ultrasound examination may be used (instead of conventional chest radiography) to confirm catheter location and exclude a pneumothorax in adult patients. Grade 2B.

Internal Jugular Location

The Panel recommends that dynamic ultrasound-guided internal jugular (IJ) venous cannulation should be used (instead of landmark technique) to improve success rate, shorten procedure time and reduce the risk of procedure-related complications in adult patients. Grade 1A.

Subclavian/Axillary Location

The Panel suggests that ultrasound dynamic guidance is of limited value for most operators to guide subclavian vein catheterization in adult patients (and that landmark technique is used instead). Grade 2C.

Femoral Location

The Panel recommends that ultrasound dynamic guidance (instead of the landmark technique) should be used to improve the success rate and reduce complications for femoral venous cannulation although this benefit is mostly realized by novice operators in adult patients. Grade 1A.

Other Locations

The Panel suggests that the use of ultrasound dynamic guidance (instead of the landmark technique) may improve the success rate and diminish complications during peripheral venous (adults and children) and arterial cannulation (adults). Grade 2B for venous and 2B for arterial catheterization.

Definitions

Levels of Quality of Evidence

Level	Points[a]	Quality	Interpretation
A	≥4	High	Further research is very unlikely to change confidence in the estimate of effect or accuracy
>B	=3	Moderate	Further research is likely to have an important impact on confidence in the estimate of effect or accuracy and may change the estimate
C	≤2	Low[b]	Further research is very likely to have an important impact on confidence in the estimate of effect or accuracy and is likely to change the estimate or any estimate of effect or accuracy is very uncertain (very low)

[a]Points are calculated based on the nine Grading of Recommendations Assessment, Development and Evaluation (GRADE) quality factors (see Table 2, section B in the original guideline document).

[b]Level C = can be divided into low (points = 2) and very low (points = 1).

Wording Based on Degree of Consensus and Strength of Recommendations

Degree of Consensus	Strength of Recommendation	Wording
Perfect consensus	Strong	Recommend: must/to be/will
Very good consensus	Strong	Recommend: should be/can
Good consensus	Conditional (weak)	Suggest: may be/may
Some consensus	Conditional (weak)	Suggest: may be
No consensus or disagreement	No	No recommendation was made regarding

Note: Rules of RAND appropriateness method (RAM) that determines the agreement and/or degree of consensus are explained in Appendix 1 and in Figure 1 in the original guideline document.

Implications of the Strong and Weak Recommendations in the Grades of Recommendation, Assessment, Development and Evaluation Method

User	Strong Recommendations	Weak (Conditional) Recommendations
Clinicians	Most patients should be offered to receive the recommendation as the most appropriate option	Recognize that different options should be offered as all will be appropriate options for different patients
Policy makers	The recommendation can be adopted as a policy in most situations	Should not be considered as a standard of care
Patient	Most patients in similar condition would accept the recommendation and only a few would not	Expected variability among different patients with your condition to choose or reject the recommendations

Clinical Algorithm(s)

None provided

Scope

Disease/Condition(s)

Any disease or condition requiring ultrasonography for organs of the chest, abdomen, pelvis, neck, and extremities

Guideline Category

Diagnosis

Evaluation

Risk Assessment

Screening

Clinical Specialty

Anesthesiology

Cardiology

Critical Care

Emergency Medicine

Nephrology

Pulmonary Medicine

Radiology

Intended Users

Advanced Practice Nurses

Allied Health Personnel

Hospitals

Nurses

Physician Assistants

Physicians

Guideline Objective(s)

To establish evidence-based guidelines for the use of bedside ultrasound by intensivists and specialists in the intensive care unit (ICU) and equivalent care sites for diagnostic and therapeutic purposes for organs of the chest, abdomen, pelvis, neck, and extremities

Target Population

Critically ill or injured adult patients

Note: Several recommendations are made regarding pediatric patients, as well, when data are sufficient to render these judgments.

Interventions and Practices Considered

Ultrasound imaging

- Diagnostic
- Interventional guidance (catheter insertion, pleural effusion drainage, paracentesis)

Major Outcomes Considered

- Sensitivity and specificity of diagnostic ultrasound
- Complication rate
- Efficiency rate

Methodology

Methods Used to Collect/Select the Evidence

Searches of Electronic Databases

Description of Methods Used to Collect/Select the Evidence

Systematic Evidence Search

A thorough systematic evidence search was done for each question/statement. This included English and translated literature. Literature related to the use of ultrasound in the intensive care unit (ICU) setting was the primary focus. If high-quality evidence was present (i.e., randomized controlled trials [RCTs] with large number of patients and no significant downgrading factors), then lower level evidence (i.e., case series) was not included. If no appropriate literature with ICU patients was available, that involving patients in all other appropriate areas such as the emergency department (ED) was considered if patients were considered equivalent. After the comprehensive literature search by the writing committee, the methodologist performed a secondary search and additional articles were included if appropriate.

The literature search was done in 2 pathways. The first pathway was a structured librarian search of MEDLINE, and EMBASE, including in-process and other no indexed citations (January 1980 to August 2015).

The Medical Subject Headings (MeSH) string utilized was (ultrasonography) AND (critical care) with both terms exploded followed by free text searches including the terms related to each specific recommendation.

The second search pathway was done by the writing committee and the experts assigned to the domains/recommendations. Screening and selection of articles to be included/excluded was done by a minimum of 2 experts to avoid selection bias.

Number of Source Documents

The articles collected by the 2 pathways were 1251 records, but only 106 were used after applying exclusion criteria.

Methods Used to Assess the Quality and Strength of the Evidence

Weighting According to a Rating Scheme (Scheme Given)

Rating Scheme for the Strength of the Evidence

Level	Points[a]	Quality	Interpretation
A	≥4	High	Further research is very unlikely to change confidence in the estimate of effect or accuracy
>B	=3	Moderate	Further research is likely to have an important impact on confidence in the estimate of effect or accuracy and may change the estimate
C	≤2	Low[b]	Further research is very likely to have an important impact on confidence in the estimate of effect or accuracy and is likely to change the estimate or any estimate of effect or accuracy is very uncertain (very low)

[a]Points are calculated based on the nine Grading of Recommendations Assessment, Development and Evaluation (GRADE) quality factors (see Table 2, section B in the original guideline document).

[b]Level C = can be divided into low (points = 2) and very low (points = 1).

Methods Used to Analyze the Evidence

Review of Published Meta-Analyses

Systematic Review with Evidence Tables

Description of the Methods Used to Analyze the Evidence

The Grading of Recommendations, Assessment, Development and Evaluation (GRADE) system was used to rank the "levels" of quality of evidence into high (A), moderate (B), or low (C).

Methods Used to Formulate the Recommendations

Expert Consensus (Consensus Development Conference)

Expert Consensus (Delphi)

Description of Methods Used to Formulate the Recommendations

Approach

There were two plenary sessions of the writing committee group leaders to establish the content. The guidelines process followed combined Grading of Recommendations Assessment, Development and Evaluation (GRADE) and RAND appropriateness method (RAM). RAM included modified Delphi method, teleconferences, and several subsequent meetings (including electronically) of subgroups.

Scientific Questions

Clinical questions related to the use of bedside ultrasound were established by the writing group for subsequent discussion, grading of evidence by a methodologist, and then voting on the overall appropriateness of the recommendation. The questions generated statements that constituted draft recommendations during the process of guideline development. (Statements can be approved and become formal recommendations or be disapproved and never reach that stage. Also, during the writing phase, it is possible to combine two or more approved statements into one recommendation.)

Development of Consensus and Clinical Recommendations

Electronic discussions and meetings occurred among subgroup members to generate the final recommendations presented. GRADE method was used to develop these evidence-based recommendations. The process involves two phases: 1) developing the recommendation and 2) determining the level of quality of evidence. Relevant articles with clinical outcomes were classified into three levels of quality based on the criteria of the GRADE methodology. This was done using GRADEpro Software (http://www.gradepro.org; McMaster University). It assesses nine quality factors including study design with five potential downgraders and three possible upgraders.

RAM was used within the GRADE steps that required panel judgment and decisions/consensus. RAM was also used in formulating the recommendations based purely on expert consensus. Recommendations were generated in two classes: strong (class 1) or weak/conditional (class 2) based on the GRADE criteria taking into consideration preset rules that defined the panel consensus/agreement and its degree. The transformation of evidence into recommendation depends not only on the level of quality of evidence but also on the panel's judgment on problem priority/importance, benefit/burden balance, and benefit/harm balance, and certainty/concern about four issues: preferences of patients, equity, acceptability, and feasibility. Combining the strength of recommendations, strong (1) or conditional/weak (2) with the "levels" of quality of evidence high (A), moderate (B), or low (C) will eventually generate six possible "grades" of recommendations (1A-1B-1C-2A-2B-2C). For example, a 1C recommendation means that although there is a lack of quality of evidence, the recommendation is strong based on expert consensus. Conversely, a 2A indicates a weak recommendation due to consideration of transformative factors despite high-quality evidence.

The RAM process included a modified Delphi method in a consensus conference and several subsequent meetings of subgroups. There were two plenary sessions of the writing committee group leaders to establish the content. Electronic discussions occurred among subgroup members to generate the final grading presented. A strong recommendation is worded as "the Panel recommends," whereas a conditional/weak recommendation as "the Panel suggests."

The implication of strong versus weak/conditional recommendation is explained in the "Rating Scheme for the Strength of the Recommendations" field. The list of the most relevant literature reference is provided for each recommendation and is limited to no more than 10 articles. Differences in opinion were resolved using a set of rules previously described in development of the Surviving Sepsis guidelines. Recommendations rendered required more than 70% of committee support. Strong recommendations required at least an 80% majority following the previously validated RAND algorithm (Figure 1 and Appendix 1 of the original guideline document).

Guidelines are based on the notion that any bedside ultrasound information is complimentary to physical examination and intensivist clinical

judgment and therefore organized around most common suspected intensive care unit (ICU) diagnoses. Guidelines for repeat examinations are predicated on significance of the change in patient condition or to follow the outcome of a therapeutic intervention.

Rating Scheme for the Strength of the Recommendations

Degree of Consensus	Strength of Recommendation	Wording
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Patient	Most patients in similar condition would accept the recommendation and only a few would not	Expected variability among different patients with your condition to choose or reject the recommendations

Cost Analysis

A formal cost analysis was not performed and published cost analyses were not reviewed.

Method of Guideline Validation

Not stated

Description of Method of Guideline Validation

Not applicable

Evidence Supporting the Recommendations

Type of Evidence Supporting the Recommendations

The type of supporting evidence is identified and graded for each recommendation (see the "Major Recommendations" field).

Benefits/Harms of Implementing the Guideline Recommendations

Potential Benefits

- Ultrasound assisted intravascular catheter insertion improves success rate, shortens procedure time and reduces the risk of procedure-related complications.
- Ultrasound can improve the success rate and help determine the safest pathway through which to perform a paracentesis. A prospective, randomized emergency medicine (EM) study of 83 patients relates a success rate of 95% versus 61% in image-guided versus blind paracentesis.
- Bedside ultrasonography may be used to provide additional valuable information to the clinical presentation to establish the diagnosis of acalculous cholecystitis.
- The use of ultrasound may be beneficial to rule in but not to rule out or exclude an effusion. Other data indicate a favorable accuracy (nearly 100%) compared with chest computed tomography (CT). Furthermore, complications (pneumothorax, failure to acquire fluid) associated with draining large pleural effusions were decreased from 33% or 50% to 0% when they were drained using ultrasound guidance.
- Renal ultrasound can readily detect the presence or absence of hydronephrosis—the indicator of obstructive uropathy—the mechanical and treatable cause of acute renal failure in those who are not hypovolemic. In addition, it can detect reduced renal size and echogenicity, features of chronic renal insufficiency and/or failure.
- Benefits of using ultrasound imaging to visualize catheter tip and guidewire in the long axis include the ability to observe the guidewire in the vessel and the tip of the needle to minimize the risk of "past pointing."

Potential Harms

Procedure-related complications (e.g., pneumothorax, failure to acquire fluid)

Qualifying Statements

Qualifying Statements

- Recommendations from these guidelines must be used in context of the clinical picture and should not supersede judgment. This document sets forth recommendations underpinned by evidence of varied quality but does not aim to define the standard of care. This is in spite of the fact that the guidelines do offer several recommendations based on high-quality evidence. Unlike guidelines based on delivering therapy or performing automated diagnostic tests, the Panel acknowledges that the present work addresses the performance of technical tasks by humans with variable degrees of proficiency. In this document, the Panel assumes that practitioners of ultrasound, be they intensivists or not, are suitably trained and competent in the technical and interpretative components of the relevant examination. It is beyond the scope to these guidelines to describe in detail the elements of training and competency. The Society of Critical Care Medicine and others have developed language and recommendations to further define parameters for training and competence elsewhere. However, the Panel does address the use of ultrasound for novice versus experienced providers where those data exist.
- It is clear that the use of intensive care unit (ICU) ultrasound is quite a dynamic field. The Panel has developed these guidelines based on current evidence. It is quite possible, even probable, that the use of ICU ultrasound (and what diagnostic and therapeutic procedures the intensivist can and should be expected to perform) will continue to evolve.

Implementation of the Guideline

Description of Implementation Strategy

An implementation strategy was not provided.

Implementation Tools

Resources

For information about availability, see the *Availability of Companion Documents* and *Patient Resources* fields below.

Institute of Medicine (IOM) National Healthcare Quality Report Categories

IOM Care Need

Getting Better

IOM Domain

Effectiveness

Patient-centeredness

Identifying Information and Availability

Bibliographic Source(s)

Frankel HL, Kirkpatrick AW, Elbarbary M, Blaivas M, Desai H, Evans D, Summerfield DT, Slonim A, Breitkreutz R, Price S, Marik PE, Talmor D, Levitov A. Guidelines for the appropriate use of bedside general and cardiac ultrasonography in the evaluation of critically ill patients-part I: general ultrasonography. Crit Care Med. 2015 Nov;43(11):2479-502. [106 references] PubMed

Adaptation

Not applicable: The guideline was not adapted from another source.

Date Released

2015 Nov

Guideline Developer(s)

Society of Critical Care Medicine - Professional Association

Source(s) of Funding

The process was conducted independent of industry funding.

Guideline Committee

Not stated

Composition of Group That Authored the Guideline

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Financial Disclosures/Conflicts of Interest

Dr. Frankel disclosed participation with another healthcare professional organization (ACS and AAST Board). Dr. Kirkpatrick disclosed a relationship with the maker of healthcare product (he received a NanoMaxx ultrasound unit for research purposes from the Sonosite); he received travel assistance from the Lifecell and Syntheses to attend Cadaver laboratories; he served on the Advisory Board for Ultrasound contrast media from the Lanthes over 5 years ago; and he disclosed participation in other healthcare professional organizations (President elect of the WSACS, Scientific Committee Member of WINFOCUS, past Pres of TAC). His institution received unrestricted funding for a randomized controlled trial (RCT) of open abdomen Mgt from the KCI. Dr. Elbarbary disclosed participation in another healthcare professional organization (board member and guideline committee chair for WINFOCUS organization). Dr. Blaivas disclosed a relationship with a healthcare provider (consultant for Sonosim) and disclosed participation in other healthcare professional organizations (ACEP, AIUM Third Vice President, SUSME President). Dr. Slonim disclosed consulting for Saint Judes and a relationship with provider of healthcare service (Saint Judes/AHRQ/NSF; ACPE-Board Member). Dr. Breitkreutz disclosed a relationship with makers of healthcare products (Consultant Fujifilm SonoSite, Consultant fees from GE, Ezono), disclosed a relationship with providers of healthcare services (Research Grant recipient, Binz-Stiftung, Ulm, Ultrasound Regional Network in Critical Care, http://www.SonoABCD.org), participates in healthcare professional organizations (DEGUM, WINFOCUS, ESICM, DIVI, and DGINA), disclosed a financial relationship with manufacturers of products/providers of services (consultant Fujifilm SonoSite; served as an expert witness). Dr. Price disclosed a relationship with Medtronic, Educational contract, valvular heart disease; Abbott Medical—medical advisory board MitraClip; board member, European Society of Cardiology Acute cardiac care, Education committee member (ESC); and CPC ESC, education committee British Society of Echocardiography, resuscitation Council UK (all cardiology). Dr. Talmor received research grant support from the Moore Foundation and disclosed participation in other healthcare professional organizations (ATS, ASA). Dr. Levitov disclosed participation in other healthcare organizations (AIUM clinical standard committee SUSME board member). The remaining authors have disclosed that they do not have any potential conflicts of interest.

Disclosures

There were no members of the committee from industry nor was there industry input into the development of the guidelines or industry presence at any meetings. No member of the guideline committee received honoraria for participation. Full disclosure of all committee members' potential conflicts at time of deliberation and publication was provided.

Guideline Status

This is the current release of the guideline.

This guideline meets NGC's 2013 (revised) inclusion criteria.

Guideline Availability

Available from the Society of Critical Care Medicine (SCCM) Web site .

Availability of Companion Documents

A podcast is available from the Society of Critical Care Medicine (SCCM) Web site .

Patient Resources

None available

NGC Status

This NGC summary was completed by ECRI Institute on June 30, 2016. The information was verified by the guideline developer on August 1, 2016.

Copyright Statement

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